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Ages of hydrothermal overprints in the Kiruna iron oxide-apatite ores as recorded in secondary monazite and xenotime

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Numerous bodies of iron oxide-apatite (IOA) ores occur associated with Palaeoproterozoic (1.90-1.87 Ga) metavolcanic rocks in northernmost Sweden. The composition of these host rocks range from basaltic to rhyolitic, with a tendency of dominance for andesitic-trachyandesitic compositions. These intermediate rocks tend to be rich in magnetite, either in the fine-grained groundmass, in veins, or in rounded nodules with sizes from a few mm to >10 cm. The ore bodies consist dominantly of magnetite and apatite in variable proportions. Important gangue minerals include actinolite, biotite, calcite, chlorite, titanite, feldspar, quartz, talc, dolomite/ankerite, anhydrite/gypsum, pyrite, and chalcopyrite. Some deposits also comprise diverse amounts of hematite.

The ore in the Kiirunavaara deposit is typically fine-grained, with a variety of complex intergrowth relations between magnetite and apatite. Monazite (Th-poor) has typically formed by a dissolution-reprecipitation process from the REE-containing apatite [1]. Fluid flow along grain boundaries and cracks in apatite interiors has depleted apatite in REE, Na, and Si, particularly in variously deformed ore types. In the more deformed ore types larger monazite grains (>100 μm) formed along grain boundaries, whereas less affected parts of the ore may show little monazite formation.

The age of the ore has previously been determined at c. 1.88 Ga [2,3]. Two samples of deformed ('banded') apatite-bearing ore were independently selected from different locations within the Kiirunavaara ore, and subjected to: i) EPMA Th-U-Pb and ii) LA-ICP-MS dating. During EPMA, 111 spot analyses of monazites along grain boundaries yielded a slope age of 1637 Ma (R^2=0.914) and a weighted average of 1638±39 Ma. Kiirunavaara monazite shows very low concentrations of: PbO 0.048, ThO_2 0.615, UO_2 0.014, and Y_2O_3 0.643 wt%, on average. The LA-ICP-MS sample was rich in cm-thick apatite bands with recrystallized monazites. Altogether 27 measured spots yielded a bimodal age spectrum indicating at least two separate ages at: 1729±16 Ma (n=14, MSWD=0.52) and 1617±17 Ma (n=13, MSWD=1.10; $^{207}Pb/^{206}Pb$ weighted averages). An additional sample from an apatite dyke in the Rektorn ore body shows abundant secondary monazite and xenotime formation, both within apatite grains and along grain boundaries. Preliminary data from 3 monazite and 5 xenotime spot analyses give a concordia age of 1721±19 Ma.

These results reinforce the presence of much younger, post-emplacement hydrothermal overprints on the Kiruna ores, previously reported [3]. The present data also corroborates U-Pb ages on apatite, monazite, titanite, and stilbite in hydrothermal veins cutting the Malmberget IOA ore [4]. Thus, at least

two stages of late hydrothermal overprinting, at c. 1.73-1.72 and 1.64-1.62 Ga, have overprinted the IOA ores in northern Sweden. The 1.73-1.72 Ga event partly overlaps with local alteration and magmatic activity elsewhere in the region, while the younger overlaps with events known further south in the Svecofennian and the SW Scandinavian Domain.

References:

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